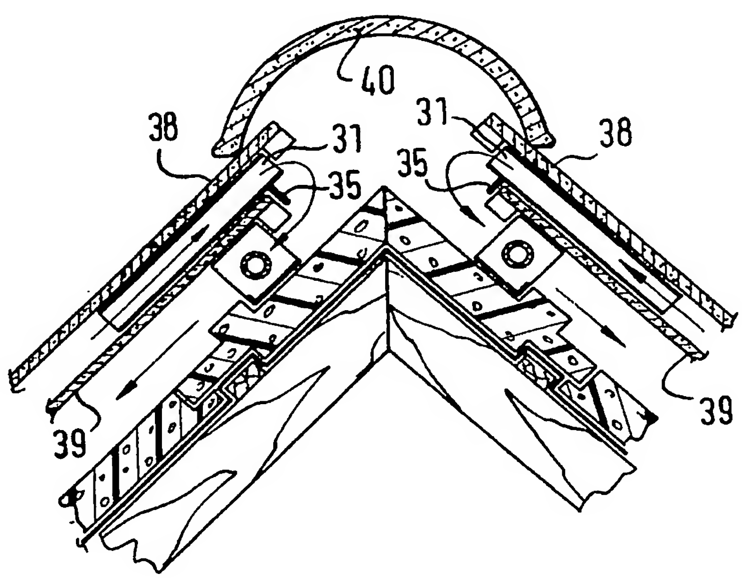
(12) UK Patent Application (19) GB (11) 2 070 232 A

(21) Application No 8105619
(22) Date of filing
23 Feb 1981
(30) Priority data
(31) 3006974
(32) 25 Feb 1980
(33) Fed Rep of Germany
(DE)
(43) Application published
3 Sep 1981
(51) INT CL^3 F24J 3/02
(52) Domestic classification
F4U 60
(56) Documents cited
GB 1568663
GB 1566411
GB 1548968
GB 1539063
(58) Field of search
F4U
(71) Applicant
Manfred Helfrecht
Poppenreuth 15–19
D-8598 Waldershof II
Federal Republic of
Germany
(72) Inventor
Manfred Helfrecht
(74) Agents
Barlow Gillett & Percival
94 Market Street
Manchester M1 1PJ

(54) Energy collecting roof structure

(57) In an energy collecting roof structure, air passes through ventilation elements 31 each sandwiched between roof tiles 38 and 39 respectively adjacent the roof structure's ridge. Heat absorbing elements, which each abut the underside of the tile 39 and a protrusion of a respective heat insulating element, each comprise a pipe for carrying a heat exchanging medium and attached to the pipe a plurality of spaced-apart convection plates. The heat absorbing elements ensure that a space is formed between the tile 39 and the heat insulating elements so that air can flow freely between them to facilitate the absorbtion of its heat.

FIG. 3



GB 2 070 232 A

FIG. 1

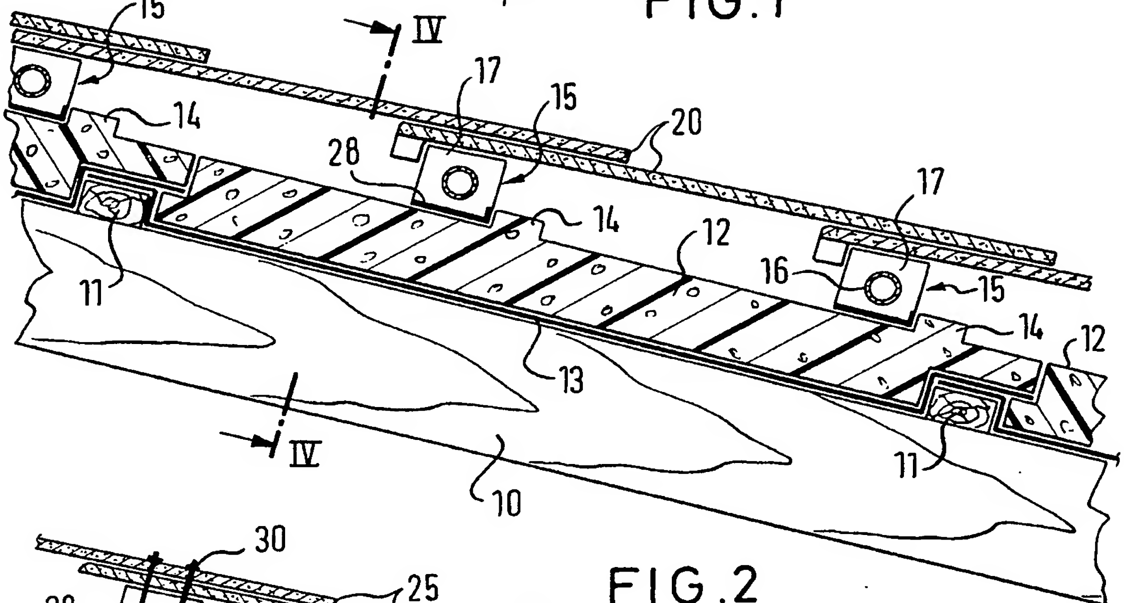


FIG. 2

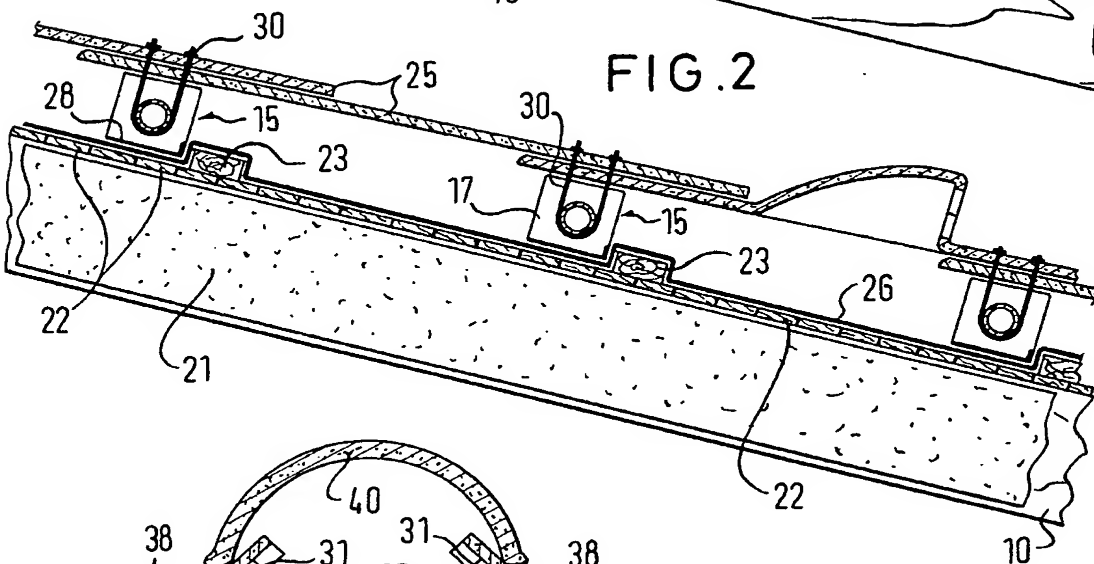
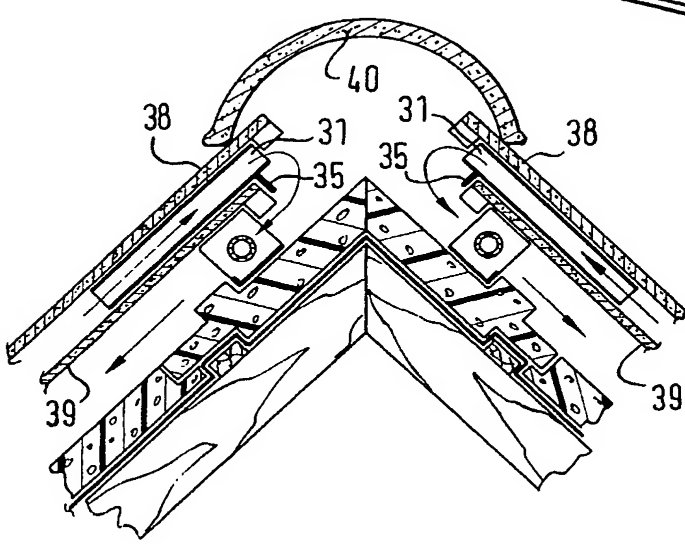


FIG. 3



2070232

2/3

FIG. 4

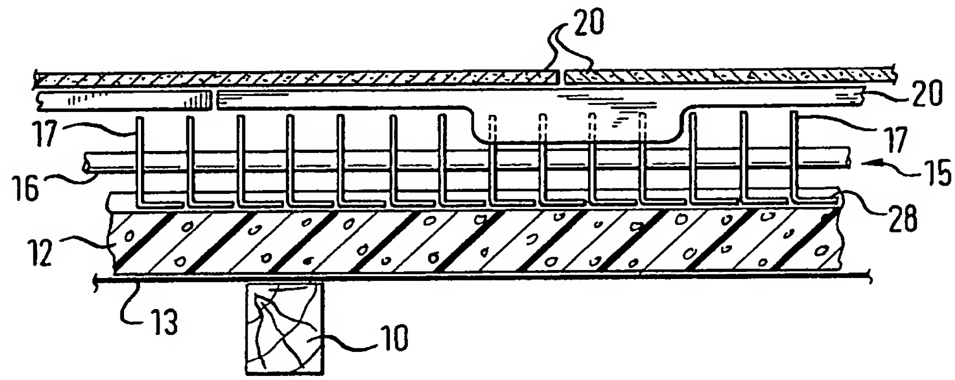


FIG.5

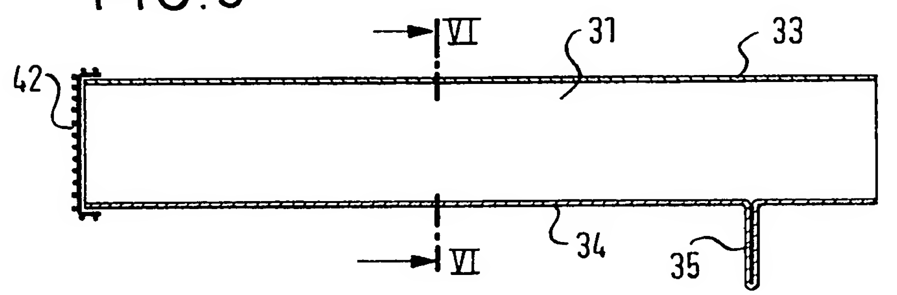


FIG.6

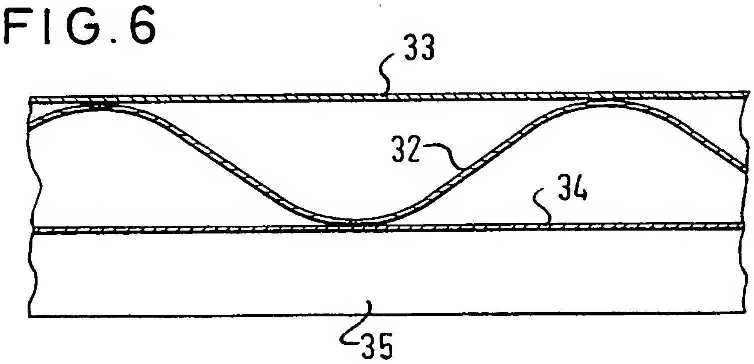


FIG. 7

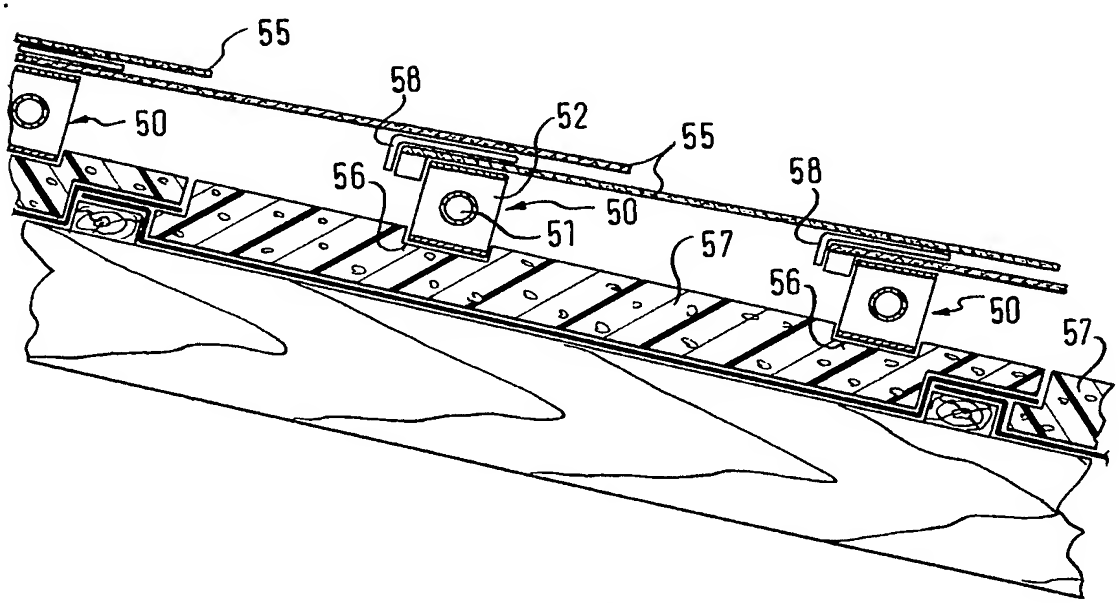
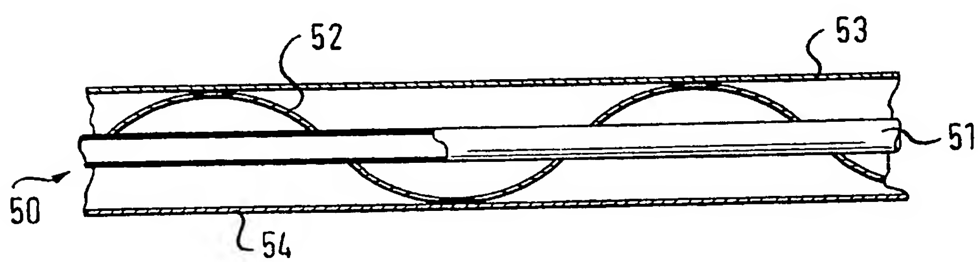


FIG. 8



SPECIFICATION

Energy collecting roof structure

This invention concerns an energy collecting roof structure in which air can circulate and which comprises a heat exchanger in the form of a plurality of heat absorbing elements in which heat exchanging medium is circulated.

It is generally known that large roof surfaces can be used for the gathering of energy, in that the roof surfaces are energy absorbing roofs in order to make use of the environment energy by means of a heat pump. The building of such energy rooves is, as ever, afflicted by great problems, since condensation forms on the absorbing surface beneath the water bearing roof covering. This condensation causes organic building materials to decay quickly and it must therefore be kept away from these. A further difficulty in the production of energy rooves arises with the energy roof which is a flat roof which because of its unavoidable profiling is unattractive and is often found to be undesirable on architectural grounds. Also with a flat roof formation of condensation is inavoidable.

An aesthetically pleasing roof structure which is usable for gathering heat from solar energy is a roof structure which has a system of pipes layed under the tiles (see German Patent No. 09 307). This roof structure which exploits solar energy indirectly in connection with a heat pump is not a completely adequate solution because of the formation of condensation and the poor exploitation of energy.

An object of the present invention is to provide an energy collecting roof structure which is aesthetically pleasing from an architectural point of view, provides a relatively high gathering of energy from the surrounding atmosphere, and in that condensation which is unavoidably formed does not damage the structure of the roof.

With this object in view the present invention provides an energy collecting roof structure in which air can circulate and which comprises a heat exchanger in the form of a plurality of heat absorbing elements in which heat exchanging medium is circulated, characterised in that each heat absorbing element consists of a pipe which extends oblique and/or vertically to the roof surface and which is provided with convector sheets fitted at right angles to the axis of the pipe and resting on a sub-structure of the roof, a water bearing roof covering being held on the heat absorbing elements and heat absorbing elements being fitted beneath the roof covering to provide a hollow space through which air passes.

In the energy collecting roof structure of the invention air circulates under the water bearing roof covering, and thereby gives up its heat to the heat conducting surfaces of the convector sheets. Since the temperature of the medium in the heat absorbing elements when a heat pump is used is essentially lower than the air temperature, relatively large quantities of energy can be taken from the air flowing past said elements. If at the same time direct radiation from the sun is also present, heat is also given off by the water bearing roof covering to the air flowing past, so that the degree of effectiveness of energy collecting can be improved. The heat absorbing elements can be connected to the water bearing roof covering and lies snugly on heat insulating elements. The heat insulating elements provide a waterproof coat, on which the heat absorbing elements are only snugly laid and thus do not pierce the waterproof coat at any point. Thus condensation which forms is led away to a gutter and any organic parts of the sub-structure do not come into contact with said condensation.

The convector sheets may be L-shaped in cross-section and have a borhole through which the pipe for the heat exchanging medium runs and in the region of which the pipe is connected heat-conductingly to the convector sheets. The convector sheets may be fastened to the pipe with a lateral clearance between them of approx. 10 mm to approx. 25 mm.

The provision of the convector sheets offer the possibility of laying the heat absorbing elements on a lattice, whereby this lattice can be traditional roof laths or lath-shaped elevations on the heat insulating elements. The shape of the convector sheets, offer the possibility for the laying of roof tiles directly on the heat absorbing elements, whereby noses of the roof tiles in each case engage snugly with the convector sheets. Because the weight of the heat absorbing elements and the roof tiles laid snugly and directly thereupon is relatively high, there is no necessity to fasten them to the roof construction through the insulation or the waterproof coat so that it is guaranteed that the heat insulating elements or the waterproof coat on the substructure is not pierced by fastening elements.

In order to avoid the convector sheets pressing into the heat insulating elements, in accordance with a further proposal of the invention, there is provided between the convector sheets and the heat insulating elements a pressure equalising strip. This pressure equalising strip can be fixed on the front edges of the convector sheets and consists preferably of a strip of angled off material, which stretches over the length of the heat absorbing elements with a width corresponding to the width of the convector sheets. The angled off part of the strip preferably has the height of a roof lath or a lattice-shaped elevation, behind which the heat absorbing element is laid snugly.

To ensure a sufficient current of air through the roof structure preferably ventilation tiles or ventilation plates are fitted in the lower region of the roof on the side of the gutter. For the formation of a ventilation plate in the region of the ridge, in accordance with a further proposal of the invention provision is made for corrugated material to be fitted in the region of the ridge.

In order to avoid the nests of birds or the penetration of small animals therein, provision is also made that an opening of the ventilation plate is provided with a wire mesh.

The convector sheets may be formed from a strip of corrugated sheet through which the pipe for the heat exchanging medium is passed. The strip of corrugated sheet can engage snugly in corresponding depressions in the heat insulating elements. If a groove-shaped depression in the heat insulating element is used then provision can be made for a pressure equalising strip to be connected to the strip of corrugated sheet from apex to apex.

For the ventilation of the hollow space under the roof covering through which air circulates provision is made that the entry of air takes place through the ventilation tiles or ventilation plates which are distributed either uniformly or regionally over the surface of the roof.

The invention will be described further, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a cross-sectional view of part of a first preferred embodiment of the energy collecting roof structure of the invention;

Figure 2 is a cross-sectional view of part of a second preferred embodiment of the energy collecting roof structure of the invention;

Figure 3 is a cross-sectional view of another part of the embodiment of Fig. 1;

Figure 4 is a sectional elevation on the line IV–IV of Fig. 1;

Figure 5 is a sectional elevation through a ventilation element which form part of the embodiment of Figs. 1, 3 and 4;

Figure 6 is a cross-sectional view of line VI–VI of Fig. 5;

Figure 7 is a cross-sectional view of part of a further preferred embodiment of the energy collecting roof structure of the invention; and

Figure 8 is a sectional view of a heat absorbing element forming part of the invention of Fig. 7.

The first preferred embodiment of the energy collecting roof structure of the invention illustrated in Fig. 1 comprises a plurality of rafters 10, of which only one is shown, on which are fitted a plurality of spaced-apart transversely extending roof laths 11. Fitted between each roof lath 11 is a respective heat insulating element 12. Each individual heat insulating element 12 lies on a foil trough 13, whereby between the roof structure's ridge and gutter the individual foil troughs 13 and heat insulating elements 12 overlap each other to form a waterproof covering. Each insulating element 12 has on its upper sides lattice-shaped elevations 14. Snugly abutting each lattice shaped elevation 14 is a heat absorbing element 15 comprising of a pipe 16 with a number of convector sheets 17 fastened to it. The convector sheets 17 are L-shaped in cross-section and are fastened to the pipe 16 by, for example, soldering with a clearance between each of approximately 10 mm so as to enable them to conduct heat. Because of the shape of the sheets 17 roof tiles 20 can be laid directly on the heat absorbing elements 15 whereby a water bearing roof covering is provided.

The convector sheets have dimensions 17 which guarantee a satisfactory circulation of air between the heat insulating elements 12 and the tiles 20.Thereby one obtains an air heat collector, in which the masses of air which circulate under the roof tiles 20 gives up heat energy to the pipes 16 and the heat exchanging medium flowing through them. Each pipe has a diameter of 10 to 12 mm and carries a convector sheet 17 100 mm × 120 mm with a clearance between each sheet 17 of 10 mm.

The heat absorbing elements 15 have, together with the tiles 20, a sufficiently great weight to ensure that the roof structure is not damaged by storm wind suction. For this reason there is no need to connect the heat absorbing elements 15 to any part of the roof structure, they can simply be laid snugly on the heat insulating elements 15. Thus piercing of the heat insulating elements 12 is avoided, as is also the possibility that condensation forming on the heat absorbing element 15 might penetrate through the heat insulating elements 15 into the sub-structure of the roof. The dimensions of the convector sheets 17 can differ from those already given but are so selected that a good circulation of air below the roof tiles 20 is guaranteed. To ensure circulation of air a number of ventilation tiles can be laid along the gutter, which ensure entry or exit of the air, although this is not shown in Fig. 1. The ventilation tiles can be so distributed over the roof structure that an optimal circulation of air for the necessary exchange of heat is obtained.

In the second preferred embodiment of the energy collecting roof structure shown in Fig. 2 each heat insulating element is fitted between the rafters 10. On the outside of each rafter 10 there is provided a covering of moulded concrete boards 22 on which laths 23 are transversely fastened with a clearance between each which is determined according to the clearance between the heat absorbing elements 15 which have to be laid and the size of the roof tiles 25. Acting as a waterproof layer is a foil sheet 26 which is laid over

the concrete boards 22 and the laths 23 and which ensures the removal of condensation to the gutter. The convector sheets 17 of the heat absorbing elements 15 are provided on their respective underside with an edge strip 28 extending at right angles. Through the provision of this edge strip 28 there results a superimposed layer with a large surface area, so that damage to the foil 26 is avoided. Instead of the edge strip 28 there can also be provided under the heat absorbing element an L-profile (not shown) which has one leg which covers the whole width of the superimposed layer of the convector sheet and another leg, which runs at right angles to the one leg and lies on the upper side of the lath 23. The tiles 25, which serve as the water bearing roof covering, can be relatively lightweight and fixed to the heat absorbing elements 15 by fastening clips 30. Despite the use of lightweight tiles it is possible to obtain heat absorbing elements of sufficiently high weight for security against storms, so that no fastening of the heat absorbing elements 15 through the waterproof layer 26 into the roof structure is necessary.

Another part of the roof structure of Fig.1, in the region of the ridge, is shown in Fig. 3. The ridge is provided with ventilation elements 31, which extend along the whole length of the ridge. As is shown in Figs. 5 and 6, these ventilation elements 31 each consist of a corrgated strip 32, which is covered above and below by a respective flat sheet 33 or 34. In order to retain the ventilation element 31 between tiles 38 and 39, the lower sheet 34 is provided with a stay 35, with which the ventilation element 31 can be hung on the tile 39 lying beneath. The ventilation element 31 is dimensioned in cross-section in accordance with the optimal throughput of air, and as is customary is closed by a conventional ridge-rider. However also possible to obtain ventilation in the ridge region by fastening the ridge-riders on spacers under which the tile is arranged with such a clearance that the necessary ventilation cross-section is obtained.

The ventilation element 31, as shown in Figs. 5 and 6, has at one end a wire mesh 42, to prevent birds from nesting in it. Instead of such a wire mesh 42, wires with clearance between each other can be stretched along the opening. These wires can be connected to the corrugated strip 32 by spot welding.

The support of the heat absorbing elements 15 on the laths 32, or on the elevations 14 of the heat insulating elements 12 has the advantage that said heat absorbing elements 15 are supported along their whole length and thus cannot sag nor droop. In this way it becomes possible to be able to produce the heat absorbing elements 15 in long lengths which are comparatively simple to lay and whereby each connecting piece can be connected with arcs which are available in series.

The afroementioned embodiment of the energy collecting roof construction exploits the generally known advantages of an air heat collector and lend themself in an optimal way to use with a tiled roof whereby heat insulation can be carried out with elements tried over many years and the prevention of the penetrating of condensation is through the roof guaranteed.

Heat absorbing elements 50 of the further preferred embodiments of the energy collecting roof structure illustrated in Fig. 7 each comprise a pipe 51, which contains heat exchanging medium, passing obliquely through a corrugated strip 52 which acts as a convector sheet and which is connected on its upper side and under side to a respective pressure equalising strip 53 or 54. This is more clearly shown in Fig. 8. Each pressure equalising strip 53 or 54 extends runs from apex to apex of the corrugated 52 and serves both to stabilise the construction and to assist the uniform laying of one side of the heat absorbing element 50 on heat insulating element 12 and roof tiles 55 on the other side of the heat absorbing element 50.

The roof tiles 55 each have a nose by which to engage behind the upper pressure equalising strip 53 of the heat absorbing element 50. The heat absorbing element 50 is in turn resting in depression 56 in the upper surface of the heat insulating element 57. The heat insulating elements 57 are held on the laths in the known way.

To guarantee the entry of air into the space under the roof tiles 55 angular spacer elements 58 are hung on the tiles 55, on which in each case the non-ridge tiles lie. In this way a uniform entry of air can be achieved over a relatively large region of the roof structure's surface to ensure sufficient ventilation.

The use of corrugated strip 52 has the advantage that the roof covering can have a shallow configuration whereby the pressure equalising strip 53 can be omited. The fastening of the corrugated strip 52 can be omitted. The fastening of the corrugated strip 52 can be done with the aid of fastening clips such as fastening clips 30 shown in Fig. 2. Furthermore, a spacer can be laid between each corrugated strip 52 in the region of the fastening clips, in order to ensure ventilation of the space under the roof tiles 55.

CLAIMS

1. An energy collecting roof structure in which air can circulate and which comprises a heat exchanger in the form of a plurality of heat absorbing elements in which heat exchanging medium is circulated, characterised in that each heat absorbing element consists of a pipe which extends oblique and/or vertically to the roof surface and which is provided

with convector sheets fitted at right angles to the axis of the pipe and resting on a sub-structure of the roof, a water bearing roof covering being held on the heat absorbing elements and heat absorbing elements being fitted beneath the roof covering to provide a hollow space through which air passes.

2. A roof structure as claimed in Claim 1 characterised in that the convector sheets are L-shaped in cross-section and each have a borehole through which the pipe for the heat exchanging medium runs and in the region of which the pipe is connected with the convector sheet as a heat exchanger.

3. A roof structure as claimed in Claim 1 or 2 characterised in that the lateral clearance between the convector sheets is approximately 10 mm to 30 mm.

4. A roof structure as claimed in Claims 2 or 3 characterised in that the convector sheets, when the diameter of the pipe is from 80 mm to 150 mm have a size of from 80 mm × 100 mm to 120 mm to 200 mm.

5. A roof structure as claimed in any preceding claim characterised in that the heat absorbing elements are arranged on a lattice, which lattice consists of lattice shaped elevations arranged on heat insulating elements.

6. A roof structure as claimed in any preceding claim characterised in that the roof covering consists of tiles having noses by which they are hung on the convector sheets.

7. A roof structure as claimed in Claims 1 to 5 characterised in that the roof covering consists of plates, each with a large surface area, which are fastened to the pipes or to the convector sheets.

8. A roof structure as claimed in any preceding claim characterised in that fitted between the heat absorbing elements and a closed sub-roof is a pressure equalising plate.

9. A roof structure as claimed in Claim 8, characised in that the pressure equalising plate is fixed to the front edges of the convector sheets.

10. A roof structure as claimed in Claim 8, characterised in that the pressure equalising plates are formed on at least one edge of the convector plates by strips of material which are angled off.

11. A roof structure as claimed in any preceding claim characterised in that in the region of the roof's ridge a corrugated material is provided for the formation of a ventilation element by which the apex lines are connected on the upper and lower sides with a sheet material and there is incorporated in the sheet material a hanging-lip or stay.

12. A roof structure as claimed in Claim 11 characterised in that an opening of the ventilation element is provided with a wire mesh.

13. A roof structure as claimed in Claim 1 characterised in that a corrugated sheet is used as a convector sheet, through which the pipe for the heat exchanging medium runs obliquely.

14. A roof structure as claimed in Claim 13 characterised in that a pressure equalising strip is connected to the corrugated strip and extends from ridge to ridge and lies form-fittingly on the sub-roof.

15. A roof structure as claimed in any preceding claim characterised in that the air enters through the ventilation elements which are distributed either uniformly or regionaly over the roof surface.

16. A roof structure as claimed in Claim 15 characterised in that the ventilation members are formed by spacers inserted between the individual elements of the roof covering.

17. A roof structure as claimed in any preceding claim characterised in that the pressure equalising strips are provided with protrusions, which engage in depressions in the heat insulating elements, for the secure retention thereon of the heat absorbing elements.

18. An energy collecting roof structure substantially as hereinbefore described with reference to and as illustrated in Figs. 1, 3,, 4, 5 and 6 or in Figs. 2, or in Figs, 7 and 8.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon) Ltd.—1981.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.